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MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Landsat 7 Mission Operations Center (MOC) to Landsat 7 Ground Station (LGS) Interface Control Document

Revision 2

October 1997

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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Prepared Under Contract NAS5-31000/HQ001057

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Preface

This document has been baselined by the Mission Operations and Systems Development Division (MOSDD) Configuration Control Board (CCB). Proposed changes to this document shall be submitted, along with supportive material justifying the change, to the Landsat 7 Mission Operations Center (MOC) Systems Manager. Changes to this document shall be made by document change notice (DCN) or by complete revision.

Questions or comments concerning this document shall be addressed to

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Abstract

This interface control document (ICD) between the Landsat 7 Mission Operations Center (MOC) and the Landsat 7 Ground Station (LGS) defines the interface according to the Open Systems Interconnection (OSI) communications reference model. Section 1 provides an overview and background of the interface. Section 2 describes the system components of the interface and summarizes the data flow between the two. Sections 3-9 describe, respectively, the application, presentation, session, transport, network, data link, and physical layers that compose the interface.

***Keywords**: interface control document (ICD), Landsat 7, Landsat 7 Ground Station (LGS), Mission Operations Center (MOC)*

Change Information Page

List of Effective Pages	
Page Number	**Issue**
Title pages	Revision 2
v through xiv	Revision 2
1-1 through 1-3	Revision 2
2-1 through 2-3	Revision 2
3-1 through 3-3	Revision 2
4-1 through 4-9	Revision 2
5-1 through 5-2	Revision 2
6-1	Revision 2
7-1	Revision 2
8-1	Revision 2
9-1	Revision 2
A-1 through A-4	Revision 2
B-1 through B-3	Revision 2
AB-1 through AB-2	Revision 2

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Contents

Preface

Abstract

Section 1. Introduction

Section 2. Interface Description

Section 3. Application Layer

Section 4. Presentation Layer

Section 5. Session Layer

Section 6. Transport Layer

Section 7. Network Layer

Section 8. Data Link Layer

Section 9. Physical Layer

Figures

Appendix A. Landsat IPDU Header Definition

Appendix B. Sample Files

Abbreviations and Acronyms

Section 1. Introduction

1.1 Purpose

This interface control document (ICD) defines the interface between the Landsat 7 Mission Operations Center (MOC) and the Landsat 7 Ground Station (LGS).

1.2 Scope

In this document, networking activities are divided into two groups: user-oriented or application services and communications-oriented or transport services. User services are concerned with the formatting and interpretation of data; transport services deal with the actual transmission of the information from one system to another.

There are seven layers within this architecture structure. The upper three layers (application, presentation, and session) are associated with user services and encompass the protocols necessary to allow two dissimilar applications or operating systems to understand each other and communicate. The fourth layer (transport) isolates the upper layers from the detailed workings of the lower, network-dependent layers. It provides for reliable data transmission regardless of the nature or reliability of lower layers. The lower three layers (network, data link, and physical) are hardware specific and encompass the protocols used to interface the data communications network with the two processors exchanging information.

To the extent possible, this ICD follows the guidelines provided by the National Aeronautics and Space Administration (NASA) in the *Handbook for Preparing Interface Control Documents for Non-Project Related Ground Facilities* (Reference 1 in Section 1.5). The guidelines have been adapted to conform to the International Organization for Standardization (ISO)/Open Systems Interconnection (OSI) network communications reference model.

1.3 Document Control

This document has been baselined by the Mission Operations and Systems Development Division (MOSDD) Configuration Control Board (CCB). Suggested or recommended changes to this ICD should be submitted to the Landsat 7 MOC Systems Manager, who will oversee their review by the elements affected by the changes. Changes agreed to by these elements shall be distributed under the direction of the Systems Manager.

1.4 Document Organization

Section 1 contains a statement of purpose and definition of the scope of this ICD. Information is provided regarding document control, organization, and supporting documents used to develop and maintain this document.

Section 2 describes the systems and the role of the interface to which this ICD applies.

Section 3 describes the application layer, which contains most user-supplied functions, the network control program, and a network management module for interactive access to the lower layers.

Section 4 describes the presentation layer, which converts data to a common format to facilitate communication between varying systems.

Section 5 discusses the session layer, which provides services such as synchronization checkpointing and error recovery to aid the orderly flow of data.

Section 6 discusses the transport layer, which provides end-to-end data integrity and quality of service functions, and assembles and disassembles packets for the network layer.

Section 7 describes the network layer, which switches and routes data transparently between computers.

Section 8 addresses the data link layer, which transfers data units to the other end of a physical link and maintains data integrity between network nodes.

Section 9 describes the physical layer, which provides bit-stream transmission over a physical medium.

Appendix A defines the Landsat 7 Internet Protocol data unit (IPDU) header, and Appendix B provides sample files. These are followed by a list of abbreviations and acronyms used in this document.

1.5 Applicable Documents

1. National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC), STDN No. 102.8, *Handbook for Preparing Interface Control Documents for Non-Project Related Ground Facilities*, 1981

2. --, STDN 724, *Tracking and Acquisition Handbook for the Spaceflight Tracking and Data Network, Revision 5,* March 1990

3. --, 533-FDD-95/003R1UD0, *Landsat 7/Flight Dynamics Facility Interface Control Document, Revision 1*, September 1997

4. --, 430-14-01-001-0, *Interface Control Document Between Landsat 7 and the Landsat 7 Ground Network (LGN)*, August 1997

5. *File Transfer Protocol*, MIL-STD-1780, May 1984

6. The Wollongong Group, Inc., *WINS TCP/IP Primer*, June 1987

7. *Transmission Control Protocol*, MIL-STD-1778, August 1983

8. *Internet Protocol*, MIL-STD-1777, 12 August 1983

9. NASA, GSFC, 430-11-06-009-A, *Landsat 7 to International Ground Station (IGS) Interface Control Document, Revision A*, September 1997

10. --, 510-1MGD/0291, *Mission Operations Division (MOD) Interface Control Document (ICD) Guidelines*, November 1991

11. --, TBD, *Memorandum of Understanding Between the Landsat 7 Processing System (LPS) and the Landsat 7 Mission Operations Center (MOC)* (Review), August 1995

12. --, 511-4SRD/0395 (CSC/SD-95/6043), *Landsat 7 Mission Operations Center (MOC) System Requirements Specification*, April 1996

13. --, 531-FPS-GN/LGS, *Landsat 7 Ground Station (LGS) Functional and Performance Specification* (Post SSR Review), December 1994

Section 2. Interface Description

2.1 General

This section provides functional descriptions of both interfacing systems, identifies the types of data exchanged across the interface, and discusses interface security and voice communications.

2.2 Interface Description Overview

2.2.1 Purpose of the Interface

The purpose of the interface is to coordinate the downlink of the Enhanced Thematic Mapper Plus (ETM+) data and the S-band forward/return link data from the Landsat 7 satellite to the LGS and to transfer S-band forward/return link data between the LGS and the MOC.

The MOC schedules the LGS contacts and commands the spacecraft to transmit ETM+ data and S-band telemetry to the LGS. The MOC sends the LGS station acquisition data and contact schedules prepass. During a pass, the MOC also sends the LGS spacecraft commands for uplink to the spacecraft.

During a pass, the LGS receives telemetry from the satellite and forwards the S-band portion to the MOC. After each contact, the LGS sends the MOC a contact status report.

The LGS keeps the MOC informed about the LGS equipment status. The MOC Flight Operations Team (FOT) and the LGS operators maintain voice contact as needed to notify each other of any sudden or unexpected changes in the spacecraft or ground equipment status.

2.2.2 MOC Description

The MOC, located at the Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, is the focal point for all Landsat 7 satellite operations. The MOC plans and schedules the operation of the spacecraft and its science payload, the ETM+. To schedule contacts with the satellite, the MOC works with multiple, existing operational resources, including NASA institutional facilities and the National Oceanic and Atmospheric Administration (NOAA). The MOC generates and validates real-time commands and stored command loads based on the conflict-free schedules. During a contact, the MOC sends the commands and loads to a ground station to be uplinked to the spacecraft. The MOC monitors the health and the status of the satellite using downlinked narrowband telemetry and analyzes the long-term performance of spacecraft subsystems.

2.2.3 LGS Description

The LGS receives the real-time and playback ETM+ wideband data transmitted by the Landsat 7 spacecraft during scheduled contacts. The LGS employs a 10-meter-class autotrack antenna to receive two 150-Mbps data signals simultaneously at different X-band frequencies. The LGS telemetry subsystem demodulates each signal into separate 75-Mbps I and Q channels and bit synchronizes each data stream. The LGS passes the four data streams through a matrix switch to the Landsat 7 Processing System (LPS). The LPS stores all wideband data at the 75-Mbps rate for later processing at a reduced rate. The LGS and the LPS are located at the Earth Resources Observation System (EROS) Data Center (EDC) in Sioux Falls, South Dakota.

The LGS also uses S-band services to transmit commands on a carrier frequency of 2106.4063 megahertz (MHz) and to receive narrowband data on a carrier frequency of 2287.5 MHz. The commands are generated in the MOC, and the narrowband telemetry is sent to the MOC.

2.3 Data Flow Summary

Figure 2-1 represents the data flow across the interface between the MOC and the LGS mapped into the ISO/OSI reference model.

2.4 Interface Security

All data transferred between the LGS and the MOC, except narrowband telemetry and command data, will be through the File Transfer Protocol (FTP) over the Transmission Control Protocol/Internet Protocol (TCP/IP). Narrowband telemetry and command data will be transferred through TCP/IP.

All data will be transferred between the LGS and the MOC over the closed Mission Operations and Data Systems Directorate (MO&DSD) Operational/Development Network (MODNET).

2.5 Voice Communications

Telephone communications between the MOC FOT and the LGS operator will occur

- During every scheduled contact
- When a last-minute change is made to the contact schedule
- When an LGS equipment failure may affect a scheduled contact
- When a spacecraft problem may affect a scheduled contact
- When the MOC and LGS wish to coordinate future activities
- To support administrative functions

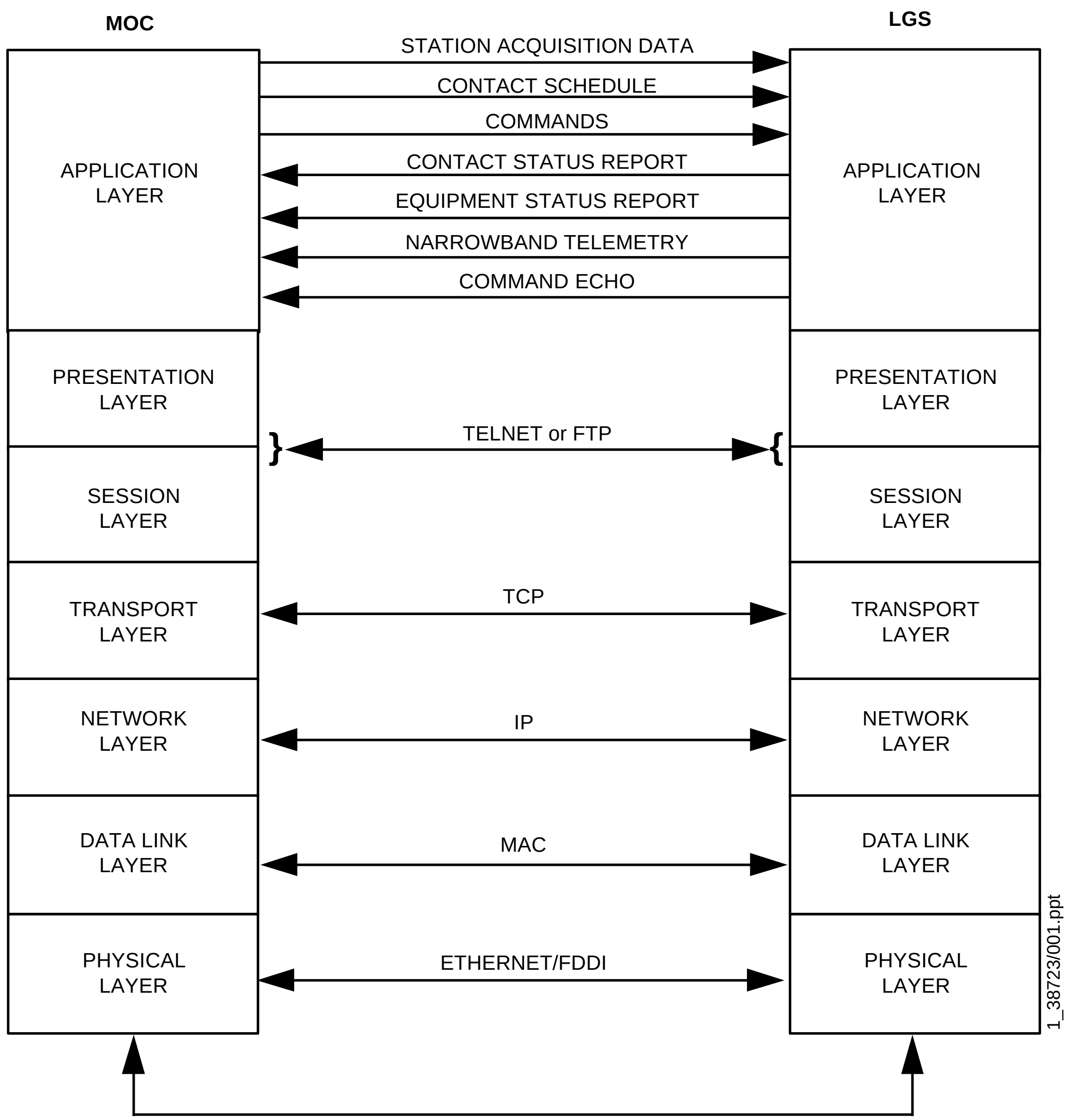

Figure 2-1. ISO/OSI Interface Reference Model

Section 3. Application Layer

3.1 General

The application layer defines the user data transferred across the interface to all user interface applications. This section describes the data and performance requirements levied on the exchange of information between the MOC and the LGS.

3.2 MOC to LGS

3.2.1 Station Acquisition Data

The MOC sends station acquisition data daily to the LGS. Although three types of station acquisition data are available, the LGS receives only the improved interrange vectors (IIRVs), which are position and velocity vectors that specify a satellite location at a given time. The station acquisition data cover a 48-hour period. The LGS employs the station acquisition data to point its antenna toward and track the Landsat 7 spacecraft.

3.2.2 Contact Schedule

The contact schedule contains the following for each scheduled transmission of wideband and narrowband data to the LGS by the Landsat 7 satellite:

- Predicted acquisition of signal (AOS) and loss of signal (LOS) times
- Scheduled start and stop times of data transmission (for wideband data only)
- X-band frequencies (for wideband data only)

The MOC produces the contact schedule daily and delivers it to the LGS before the first contact listed in the schedule. The contact schedule covers a 48-hour period. A revised contact schedule is sent whenever an unexpected schedule change occurs.

3.2.3 Commands

The MOC will send commands to the LGS for transmission to the satellite during every pass that has S-band services requested. As a backup for the Alaska ground station (AGS), the MOC can send command data loads to the LGS. The commands will be packaged in command IPDUs as defined in the Landsat IPDU header definition in Appendix A. There will be a dedicated socket between the LGS and the MOC for transmission of the command IPDUs. The LGS will be the server for this connection.

3.3 LGS to MOC

3.3.1 Contact Status Report

The contact status report contains

- Predicted AOS and LOS times
- Scheduled start and stop times of data transmission
- Observed start and stop times of bit synchronization
- X-band frequencies of data reception
- Notes on any problems or unusual conditions

The LGS sends a contact status report to the MOC after every scheduled contact through closed MODNET.

3.3.2 Equipment Status Report

The equipment status report contains

- Time the LGS equipment problem occurred
- Brief description of the problem
- Estimated time of return to normal operations

The LGS sends an equipment status report to the MOC whenever a problem occurs that prevents the reception of wideband data during a scheduled contact. Another equipment status report is sent when the problem is rectified and the equipment is returned to service. These reports are sent through closed MODNET.

3.3.3 Narrowband Telemetry

Real-time and playback narrowband data are modulated onto one carrier; real-time data modulates the subcarrier, playback data modulates the baseband. For every pass that has S-band services requested, the LGS will process each data stream independently and will transfer them to the MOC. The telemetry will be packaged with one channel access data unit (CADU) per telemetry IPDU as defined in the Landsat IPDU header definition in Appendix A. There will be dedicated sockets between the LGS and the MOC for separate transfer of real-time and playback narrowband telemetry IPDUs. The LGS will act as the server for these connections. These connections will be through closed MODNET.

3.3.4 Command Echo

The LGS will support the capability to send command echoes to the MOC. A command data IPDU will be echoed back to the MOC from the ground station by retaining the data portion of the IPDU and, in the IPDU header, swapping the source and destination codes, changing the message type code, and updating the message time field.

When a command IPDU marked as a test command (item number 11 in the IPDU header set to 1) is received by the LGS, the LGS will not uplink the data portion of the IPDU. However, the command will be echoed back to the MOC by the LGS as described above. Item 11 will remain set to 1 in the test command echo IPDU. There will be dedicated sockets between the LGS and the MOC for separate transfer of command data IPDUs. The LGS will act as the server for these connections. These connections will be through closed MODNET.

Section 4. Presentation Layer

4.1 General

The following subsections describe the format of the data to be transferred between the MOC and the LGS.

4.2 MOC to LGS

4.2.1 Station Acquisition Data

The station acquisition data files delivered to the LGS are in the same format as the station acquisition data files that are generated by the Flight Dynamics Facility (FDF) software resident in the MOC. The file format is described in the *Landsat 7/Flight Dynamics Facility Interface Control Document* (Reference 3).

The file-naming convention for the station acquisition data is

L7yyyydddLGSIRV.Snn

where	L7	is the mission ID
	yyyy	is the year for which the data apply
	ddd	is the first day of the interval for which the data apply (001-366)
	LGSIRV	indicates that the file contains IIRVs for the LGS
	S	specifies the sequence number follows
	nn	is the sequence number of the file for the year and day of year (00-99)

4.2.2 Contact Schedule

The contact schedule files delivered to the LGS are in the same format as the contact schedule files that are generated by the MOC scheduling system for each International Ground Station (IGS) and the LPS. A sample contact schedule is shown in Figure B-1 in Appendix B.

The contact schedule message contains a two-element standard header, a one-element fixed form message body, and a one-element standard trailer. Figure 4-1 shows the format of the contact schedule message. One or more acquisitions can be reported in the message body.

```
TYPE:             SCH
DTG:              yyyy/ddd:hh:mm:ss
SCHEDULED EVENT:  x yyyy-mm-dd:hh:mm:ss hh:mm:ss yyyy-mm-dd:hh:mm:ss hh:mm:ss xx x
SCHEDULED EVENT:  x yyyy-mm-dd:hh:mm:ss hh:mm:ss yyyy-mm-dd:hh:mm:ss hh:mm:ss xx x
                    ⋮
TEXTEND:
```

Figure 4-1. Contact Schedule Message Format

A description of each element of the contact schedule message follows.

TYPE is a 3-character field indicating the message is a contact schedule message.

SCH = contact schedule message

DTG is a 17-character field that specifies the GMT date and time of the message origination.

1996 through 2100 = year (yyyy)

001 through 366 = day of year (ddd)

00 through 23 = hour (hh)

00 through 59 = minute (mm)

00 through 59 = second (ss)

SCHEDULED EVENT contains 7 fields of information, separated by an American Standard Code for Information Interchange (ASCII) space character. One or more SCHEDULED EVENT lines are used for the acquisition pass to indicate the AOS, LOS, and data times for the X-band and S-band data transmissions.

NOTE: The data start time corresponds to the first bit of payload correction data (PCD) followed by the image data. The data stop time corresponds to the last bit of PCD data being transmitted.

Some of the information in this field is not needed by the ground station to perform its operations. However, the additional information may be of value in resolving operational problems.

Field 1 is a 1-character field indicating the origination source of the data.

7 = Landsat 7

Field 2 is a 19-character field indicating the GMT date and time when the satellite transmitter will be turned on (AOS).

1996 through 2100 = year (yyyy)

01 through 12 = month (mm)

01 through 31 = day (dd)

00 through 23 = hour (hh)

00 through 59 = minute (mm)

00 through 59 = second (ss)

Field 3 is an 8-character field indicating the GMT time when the first data block will be received.

00 through 23 = hour (hh)

00 through 59 = minute (mm)

00 through 59 = second (ss)

NOTE: For S-band data, this time be the same as AOS.

Field 4 is a 19-character field indicating the GMT date and time when the last data block will be received.

1996 through 2100 = year (yyyy)

01 through 12 = month (mm)

01 through 31 = day (dd)

00 through 23 = hour (hh)

00 through 59 = minute (mm)

00 through 59 = second (ss)

NOTE: For S-band, this time will be the same as LOS.

Field 5 is an 8-character field indicating the GMT time when the satellite transmitter will be turned off (LOS).

00 through 23 = hour (hh)

00 through 59 = minute (mm)

00 through 59 = second (ss)

Field 6 is a 2-character field indicating the carrier frequency.

XL = X-band low frequency (8082.5 MHz)

XM = X-band middle frequency (8212.5 MHz)

XH = X-band high frequency (8342.5 MHz)

S1 = high data rate, coherent

S2 = low data rate, coherent

S3 = high data rate, noncoherent

S4 = low data rate, noncoherent

Field 7 is a 1-character field indicating the satellite antenna to be used.

1 = X-band antenna 1

2 = X-band antenna 2

3 = X-band antenna 3

4 = S-band omni antenna

TEXTEND is a message trailer and consists of the single element "TEXTEND:" This provides a definite indication that there are no additional message lines.

The file-naming convention for the contact schedule is

L7yyyydddLGSSCH.Snn

where	L7	is the mission ID
	yyyy	is the year for which the schedule applies
	ddd	is the first day of the interval for which the schedule applies (001-366)
	LGSSCH	indicates that the file contains the contact schedule for the LGS
	S	specifies the sequence number follows
	nn	is the sequence number of the file for the year and day of year (00-99)

4.2.3 Commands

For a complete description of the commands and the transfer protocol, see the ICD between Landsat 7 and the LGN (Reference 4).

4.3 LGS to MOC

4.3.1 Contact Status Report

Each contact status report is a file in ASCII format. The file is composed of records of variable length. The file contains a group of header records followed by three sequences of data records followed by a group of trailer records. A sample contact status report file is shown in Figure B-2 in Appendix B.

The first two records in the file contain the header information. The format of the header records is shown in Figure 4-2. The name of the X-band ground station is contained in the first record beginning at column 17. The contact date is specified in the second record starting at column 15. The contact date is the predicted AOS date provided by the contact schedule. The contact date is represented by mm/dd/yyyy (month/day/year).

```
Rec|Columns
#  |0            1 1                                                      7
---|1------------5-7------------------------------------------------------0
1  |GROUND STATION: LGS, SIOUX FALLS, SD
2  |CONTACT DATE: mm/dd/yyyy
```

Figure 4-2. Format of Header Records (Contact Status Report)

Three sequences of data records follow the header records. The contact status report contains one sequence of data records for each X-band frequency. An active data record sequence is present if wideband data were scheduled for downlink on the X-band frequency. An inactive data record sequence is present if no wideband data were scheduled for downlink on the X-band frequency. The data record sequences appear in increasing order of the X-band frequency designator.

The format of the active data record sequence is shown in Figure 4-3. The first two records are empty. The third record contains the X-band frequency designator (X) and the column headings for the data in the fourth record. The fourth record contains

- Predicted AOS time (HH:MM:SS)
- Predicted LOS time (HH:MM:SS)
- Scheduled start time for wideband data transmission (HH:MM:SS)
- Scheduled end time for wideband data transmission (HH:MM:SS)
- Optional remark number (R)

```
Rec|Columns
#  |0       0   1      2   2      3   3        4   4       5   6     6   7
---|1-------9---3------0---4------1---5--------4---8-------6---0-----6---0
1  |
2  |
3  |LINK X        AOS        LOS      DATA START   DATA STOP   REMARKS
4  |            HH:MM:SS   HH:MM:SS    HH:MM:SS     HH:MM:SS   R
5  |
6  |BIT SYNCH     LOCK       LOSS
7  |STRING S    HH:MM:SS   HH:MM:SS
8  |            HH:MM:SS   HH:MM:SS
.  |                .          .
.  |                .          .
N  |            HH:MM:SS   HH:MM:SS
```

Figure 4-3. Format of Active Data Record Sequence (Contact Status Report)

The times are copied from the contact schedule. The fifth record is empty. The sixth record contains the column headers for the bit synch lock and loss times. The seventh record holds

- String identifier (S)
- Bit synch lock time (HH:MM:SS)
- Bit synch loss time (HH:MM:SS)

The optional eighth record holds the next bit synch lock and loss times, if observed, for the X-band frequency. Records with the format of the eighth record may be repeated as many times as is required to list the succeeding intervals of bit synch during the contact at the X-band frequency.

The AOS and LOS times and the data start and stop times are expressed as HH:MM:SS (hours, minutes, seconds) on a 24-hour clock. All times are expressed as universal time coordinated (UTC). The X-band frequency designators are 1 for the low frequency (8082.5 MHz), 2 for the middle frequency (8212.5 MHz), and 3 for the high frequency (8342.5 MHz).

The format of the inactive data record sequence is shown in Figure 4-4. The first two records are empty. The third record contains the X-band frequency designator and the column headings for the data in the fourth record. The keyword INACTIVE appears in the fourth record beginning at column 1. The fifth record is empty. The sixth record contains the column headers for the bit synch lock and loss times. The keyword INACTIVE appears in the seventh record beginning at column 1.

```
Rec|Columns
#  |0       0   1      2   2      3   3        4   4       5   6     6   7
---|1-------9---3------0---4------1---5--------4---8-------6---0-----6---0
1  |
2  |
3  |LINK X       AOS        LOS      DATA START   DATA STOP   REMARKS
4  |INACTIVE
5  |
6  |BIT SYNCH    LOCK       LOSS
7  |INACTIVE
```

Figure 4-4. Format of Inactive Data Record Sequence (Contact Status Report)

The format of the trailer records is shown in Figure 4-5. The first two records are empty. The third record contains the header for remarks by the LGS operator. The optional fourth and remaining records contain free text comments. A comment record beginning with a remark number must be present for each remark number that appeared in the active data record sequences. The group of trailer records may also include comments with no reference to a remark number. Each comment record contains 70 or fewer ASCII printable characters and blanks.

```
Rec|Columns
#  |0               1                                                     7
---|1---------------7-----------------------------------------------------0
1  |
2  |
3  |OPERATOR REMARKS:
4  |
.  |
.  |
N  |
```

Figure 4-5. Format of Trailer Records (Contact Status Report)

The file-naming convention for the contact status report is

L7yyyydddLGSCTS.Snn

where	L7	is the mission ID
	yyyy	is the year for which the status report applies
	ddd	is the day of the year of the predicted AOS (001-366)
	L G S C T	indicates that the file contains a contact status report from the LGS

S

S specifies the sequence number follows

nn is the sequence number of the file for the day of year and hour of day (00-99)

4.3.2 Equipment Status Report

Each equipment status report is an ASCII file that contains records of variable length. The file contains a header record followed by one or more sequences of data records. A sample equipment status report file is shown in Figure B-3 in Appendix B.

The first two records in the file contains the header information. The format of the header records is shown in Figure 4-6. The name of the X-band ground station is contained in the record beginning at column 17. The status date is specified in the second record starting at column 17. The status date is the date for which the report applies (i.e., the current date). The status date is represented by mm/dd/yyy (month/day/year).

```
Rec|Columns
#  |0              1                                                    7
---|1--------------7----------------------------------------------------0
1  |GROUND STATION: LGS, SIOUX FALLS, SD
2  |DATE OF STATUS: mm/dd/yyyy
```

Figure 4-6. Format of Header Records (Equipment Status Report)

The format of the data record sequence is shown in Figure 4-7. The first two records are empty. The third record contains the column headings for the data in the fourth record. The fourth record contains

- String identifier (S)
- Severity status (COLOR)
- When the equipment went down (YYYY:DDD:HH:MM)
- Expected time of return to operation (YYYY:DDD:HH:MM)

```
Rec|Columns
#  |0    0   1    1   1            3   3            4                   7
---|1----6---0----5---9------------2---6------------9-------------------0
1  |
2  |
3  |STRING   STATUS     DOWNTIME         ETRO
4  |   S     COLOR    YYYY:DDD:HH:MM   YYYY:DDD:HH:MM
5  |
6  |IMPACT/REMARKS:
7  |
.  |
.  |
N  |
```

Figure 4-7. Format of Data Record Sequence (Equipment Status Report)

The fifth record is empty. The sixth record contains the header for remarks by the LGS operator. The optional seventh and remaining records contain free text comments. Each comment record contains 70 or fewer ASCII printable characters and blanks.

The status may be RED, YELLOW or GREEN. RED indicates that the string cannot receive wideband data from the spacecraft. YELLOW means that the operational performance of the string is uncertain. GREEN indicates that the string can handle wideband data. The downtime and the expected time of return to operation (ETRO) are represented by YYYY:DDD:HH:MM (four digits of the year, day of the year, hour, and minute) in UTC.

The file-naming convention for the equipment status report is

L7yyyydddLGSEQS.Snn

where	L7	is the mission ID
	yyyy	is the year when the report was generated
	ddd	is the day of the year when the report was generated (001-366)
	LGSEQS	indicates that the file contains an equipment status report from the LGS
	S	specifies the sequence number follows
	nn	is the sequence number of the file for the year and day of year (00-99)

4.3.3 Narrowband Telemetry

The LGS provides synchronization and Reed-Solomon data correction for both real-time and playback narrowband telemetry. It maintains real-time and playback telemetry as two independent data streams.

For a complete description of the telemetry and its transfer protocol, see the ICD between Landsat 7 and the LGN (Reference 4).

4.3.4 Command Echo

For a complete description of the telemetry and its transfer protocol, see the ICD between Landsat 7 and the LGN (Reference 4).

Section 5. Session Layer

5.1 General

The session layer provides system-dependent, process-to-process communications functions, which include

- Receipt and processing of incoming and outgoing logical link connect, disconnect, and abort requests
- Receipt and processing of incoming and outgoing data
- Detection of network disconnects and failure of the transport layer to deliver data in a timely manner

FTP is the Internet standard, high-level protocol for transferring files from one machine to another. The server side requires a client to supply a login identifier and password before it will honor file transfer requests. This layer will comply with the FTP standard as specified in the Internet request for comment (RFC).

The FTP protocol governing this layer is described in *File Transfer Protocol* (Reference 5) and *WINS TCP/IP Primer* (Reference 6).

5.2 MOC to LGS Transmissions

The MOC uses FTP to transfer the station acquisition data and the contact schedules from the MOC to the LGS. The MOC employs the FTP put command to place the files in a designated directory on the LGS computer. If the files cannot be transferred, the FOT notifies the LGS personnel by telephone.

The LGS operator informs the MOC FOT by telephone of the current network address of the LGS computer, the user account name, the account password, and the specification of the directory that receives the station acquisition data and the contact schedules. The LGS operator changes the account password at frequent intervals and notifies the MOC FOT by telephone of the new password.

5.3 LGS to MOC Transmissions

The LGS uses the FTP to transfer the contact status reports and the equipment status reports from the LGS to the MOC. The LGS employs the FTP put command to place the files in a designated directory on the MOC data server. If the files cannot be transferred, LGS personnel notify the MOC FOT by telephone.

The MOC FOT informs the LGS operator by telephone of the current network address of the MOC data server, the user account name, the account password, and the specification of the directory that receives the contact status reports and the equipment status reports. The MOC FOT changes the account password at frequent intervals and notifies the LGS operator by telephone of the new password.

Section 6. Transport Layer

The transport layer provides a system-independent, process-to-process communications service in association with the underlying services provided by the lower layers. The transport layer permits two systems to exchange data reliably and sequentially, regardless of their location within a network.

TCP is the standard transport-level protocol that provides the reliable, full duplex, stream service on which many application protocols depend. TCP allows a process on one machine to send a stream of data to a process on another. It is connection oriented (i.e., before transmitting data, participants must establish a connection). This layer complies with the TCP standard as specified in the Internet RFC.

The TCP protocol governing this layer is described in the *Transmission Control Protocol* (Reference 7) and the *WINS TCP/IP Primer* (Reference 6).

Section 7. Network Layer

The network layer provides transparent data transfer between two transport layer entities. The network layer accepts packets from the transport layer at the source node and forwards them to the destination node.

IP is the Internet standard protocol that defines the Internet datagram as the unit of information passed across the Internet and provides the basis for the Internet connectionless, best-effort packet delivery service. This layer complies with the IP standard as specified in the Internet RFC.

The IP protocol governing this layer is described in *Internet Protocol* (Reference 8) and *WINS TCP/IP Primer* (Reference 6).

Section 8. Data Link Layer

The data link layer creates the communications path between adjacent nodes and ensures the integrity of the data transferred between them. Functions covered by this layer include

- Establishing and terminating the link
- Detecting and responding to link transmission errors
- Synchronizing link data transmissions and reporting link status

The protocol governing this layer is the standard for transmitting IP datagrams over Ethernet networks. The IP datagram is the basic unit of information passed across the Internet. It contains a source and destination address along with data. This layer complies with the IP datagram Internet standards as specified in the Internet RFCs.

Section 9. Physical Layer

The physical layer manages the physical transmission of data over a channel, which includes

- Monitoring change signals
- Handling hardware interrupts
- Informing the data link layer when transmission is complete

The MOC uses a standard 802.3 local area network (LAN), connected to MODNET. Nascom provides connections between the MODNET and the LGS network for MOC and LGS electronic communications.

Appendix A. Landsat IPDU Header Definition

The general Landsat 7 telemetry and command IPDU format is as follows:

IPDU header (32 bytes)	IPDU data (variable length): For telemetry: one CADU For commands and command echoes: preamble, command link transmission unit (CLTU), and postamble

The IPDU header definition, as defined in Table A-1, will be used for Landsat 7 telemetry and command IPDUs. Network Control Center (NCC) IPDUs will have a different set of formats.

Real-time narrowband telemetry IPDUs, spacecraft recorder playback narrowband telemetry IPDUs, command IPDUs, and command echo IPDUs will each have their own dedicated sockets between the MOC and the ground station.

Table A-1. Landsat 7 IPDU Header Field (1 of 2)

Item No.	Field Name	Format and Size	Value	Used for Tlm	Used for Cmd
1	IPDU synchronization	Unsigned integer (4 bytes)	74C2472C hex	x	x
2	IPDU length in bytes (everything from the start of IPDU synch field through the end of the IPDU)	Unsigned integer (4 bytes)		x	x
3	Data type ID, consisting of	(4 bytes total)			
3a	IPDU source	Unsigned integer (8 bits)	Nascom assigned ID for source of IPDU (see Table A-2 for Landsat 7 values)	x	x
3b	IPDU destination	Unsigned integer (8 bits)	Nascom assigned ID for destination of IPDU (see Table A-2 for Landsat 7 values)	x	x
3c	Message type	Unsigned integer (8 bits)	(see Table A-3 for Landsat 7 values)	x	x
3d	Spare	(8 bits)	0		
4	Header version number	Unsigned integer (4 bits)	1	x	x
5	Data type	Unsigned integer (4 bits)	0 (unused for Landsat 7)		
6	Message time (GMT)	NASA PB-5 code (option C) (7 bytes)	(see Table A-4 for Landsat 7 values)	x	x
7	Ground station physical port ID	Unsigned integer (1 byte)	0 (unused for Landsat 7)		
8	Source VCDU sequence counter discontinuity	Logical (1 bit)	0 = no source VCDU discontinuity 1 = source VCDU discontinuity detected	x	
9	VCDU contains playback data	Logical (1 bit)	0 = real-time narrowband data 1 = recorder playback narrowband data	x	
10	Recovery processing indicator	Logical (1 bit)	0 = live from spacecraft 1 = playback from ground station	x	
11	Test data indicator	Logical (1 bit)	0 = operational data 1 = test data	x	x
12	CRC failure indicator	Logical (1 bit)	0 (unused for Landsat 7)		

Table A-1. Landsat 7 IPDU Header Field (2 of 2)

Item No.	Field Name	Format and Size	Value	Used for Tlm	Used for Cmd
13	Path SDU source sequence counter discontinuity	Logical (1 bit)	0 (unused for Landsat 7)		
14	Packet length error	Logical (1 bit)	0 (unused for Landsat 7)		
15	Packet fill indicator	Logical (1 bit)	0 (unused for Landsat 7)		
16	Spare	(2 bits)	0		
17	Source VCDU ID, consisting of	Unsigned integer (14 bits total)			
17a	Spacecraft ID	Unsigned integer (8 bits)	15 hex for Landsat 7	x	x
17b	Virtual channel ID	Unsigned integer (6 bits)	0 for all VCDUs for Landsat 7 narrowband telemetry	x	
18	Location of first octet of EDOS-generated fill data for a path SDU	Unsigned integer (2 bytes)	0 (unused for Landsat 7)		
19	Spare	(4 bytes)	0		
20	Reed-Solomon error control flag	Logical (1 bit)	0 = no errors or errors were corrected 1 = uncorrectable errors	x	
21	Source VCDU header error decode results	Unsigned integer (5 bits)	0 (unused for Landsat 7)		
22	Source VCDU error decode results	Unsigned integer (10 bits)	Applicable only if the value of the Reed-Solomon error control flag = 0: 0 = no errors > 0 = number of corrected bits within the entire VCDU	x	
	Total Header Length	**32 bytes**			

Table A-2. Source and Destination Codes

Source/Destination Identification	Corresponding Integer Code (8 bits) (hex)	Corresponding 3-Character ASCII Code
Landsat 7 MOC	01	L7M
Sioux Falls, SD, S-band	02	LGS
EOS Alaska	03	AGS
EOS Spitzbergen Island	04	SGS
EOS White Sands Communications	05	WSC
Weilheim	06	WIL
Valley Forge	07	VLF
Vandenburg AFB	08	VAF
NASA Wallops	60	WPS

Table A-3. Message Types

Message Type	Corresponding Integer Code (8 bits) (hex)
Narrowband real-time telemetry	01
Narrowband spacecraft recorder telemetry	02
Command data message	03
Command echo message	04

Table A-4. NASA PB-5 Time Code Format (Option C)

Item No.	Field Name	Format and& Size	Value
1	Flag bit	Logical (1 bit)	1
2	Truncated Julian day	Unsigned integer (14 bits)	Truncate the most significant decimal digits, retaining only the four least significant ranging from 0 to 9999. The current Julian day epoch begins at midnight 1995, October 9. October 10, 1995, is day 0.
3	Seconds of day	Unsigned integer (17 bits)	Range = 0 to 86399
4	Milliseconds of second	Unsigned integer (10 bits)	Range = 0 to 999
5	Microseconds of millisecond	Unsigned integer (10 bits)	Range = 0 to 999
6	Spare	(4 bits)	
	Total Length	**7 bytes**	

Appendix B. Sample Files

This appendix provides samples of the following files that are sent by the LGS to the MOC:

- Contact schedule
- Contact status report
- Equipment status report

```
TYPE:                SCH
DTG:                 1996/300:20:30:30
SCHEDULED EVENT:     7 1998-10-16:09:30:30 09:35:00 1998-10-16:09:43:30 09:40:35 XL 1
SCHEDULED EVENT:     7 1998-10-16:09:30:30 09:30:30 1998-10-16:09:40:35 09:40:35 S1 4
SCHEDULED EVENT:     7 1998-10-16:11:30:30 11:35:00 1998-10-16:11:43:00 11:40:35 XM 1
SCHEDULED EVENT:     7 1998-10-16:11:30:30 11:30:30 1998-10-16:11:40:35 11:40:35 S1 1
TEXTEND:
```

Figure B-1. Sample Contact Schedule

```
GROUND STATION: LGS, SIOUX FALLS, SD
CONTACT DATE: 01/26/1999


LINK 1          AOS         LOS       DATA START   DATA STOP   REMARKS
             01:00:00   01:15:00    01:01:00     01:14:00

BIT SYNCH       LOCK        LOSS
STRING 1     01:00:20   01:14:30


LINK 2          AOS         LOS       DATA START   DATA STOP   REMARKS
             01:00:00   01:15:00    01:01:00     01:10:00    1

BIT SYNCH       LOCK        LOSS
STRING 3     01:01:00   01:01:10
             01:01:30   01:09:20
             01:09:40   01:12:15


LINK 3          AOS         LOS       DATA START   DATA STOP   REMARKS
INACTIVE

BIT SYNCH       LOCK        LOSS
INACTIVE


OPERATOR REMARKS:
1.  Children of visiting state government officials were playing with the
switches on the control panel for string 3.
```

Figure B-2. Sample Contact Status Report

```
GROUND STATION: LGS, SIOUX FALLS, SD
DATE OF STATUS: 09/20/1999

STRING   STATUS     DOWNTIME         ETRO
   1     RED      99:263:01:14   99:270:18:00

IMPACT/REMARKS:
Replacement part on back order.  ETRO is optimistic.


STRING   STATUS     DOWNTIME         ETRO
   3     GREEN    99:262:22:37   99:263:01:30

IMPACT/REMARKS:
Remains of electrocuted mouse cleaned out of power supply.
```

Figure B-3. Sample Equipment Status Report

Abbreviations and Acronyms

AOS	acquisition of signal
ASCII	American Standard Code for Information Interchange
CADU	channel access data unit
CCB	Configuration Control Board
CLTU	command link transmission unit
CRC	cyclic redundancy check
DCN	document change notice
EDC	EROS Data Center
EDOS	Earth Observing System (EOS) Data and Operations System
EROS	Earth Resources Observation System
ETM+	Enhanced Thematic Mapper Plus
ETRO	expected time of return to operation
FDDI	fiber-distributed data interface
FDF	Flight Dynamics Facility
FOT	Flight Operations Team
FTP	File Transfer Protocol
GMT	Greenwich mean time
GSFC	Goddard Space Flight Center
ICD	interface control document
IGS	International Ground Station
IIRV	improved interrange vector
IP	Internet Protocol
IPDU	IP data unit
ISO	International Organization for Standardization
LAN	local area network
LGS	Landsat 7 Ground Station
LOS	loss of signal

LPS	Landsat 7 Processing System
MAC	media access control
Mbps	megabits per second
MHz	megahertz
MO&DSD	Mission Operations and Data Systems Directorate
MOC	Mission Operations Center
MODNET	MO&DSD Operational/Development Network
MOSDD	Mission Operations and Systems Development Division
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications
NCC	Network Control Center
NOAA	National Oceanic and Atmospheric Administration
OSI	Open Systems Interconnection
PCD	payload correction data
RFC	request for comment
SDU	source data unit
TBR	to be resolved
TCP	Transmission Control Protocol
UTC	universal time coordinated
VCID	virtual channel identifier
VCDU	virtual channel data unit
WRS	Worldwide Reference System